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Network Effects in the German Magazine Industry

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Abstract

This paper examines the two-sided network effects in the German magazine industry. We specify and estimate the network effect functions for readers and advertisers nonparametrically and find that they are neither linear nor monotonic.

Keywords: Two-sided markets, Network externality, Nonparametric IV

JEL Classification: C14, C30, L14

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1 Introduction

In the magazine industry indirect network effects exist between readers and advertisers such that advertisers prefer to advertise in a magazine with a higher circulation rate while readers' demand may or may not depend on the number of advertisements in the magazine. In much theoretical and empirical work, utilities of the two sides, namely readers and advertisers, are assumed to be linear in network effects, see, for instance Rochet and Tirole (2003); Armstrong (2006); Kaiser and Wright (2006); Rysman (2004). Recently, using a semiparametric model, Sokullu (2015) has shown that network effects are not linear in the local daily newspaper industry in the U.S. This paper closely follows the approach of Sokullu (2015) to develop a magazine market model and estimate network effects in the German magazine industry and shows that they are neither linear nor monotonic. The correct specification of these effects are important since they play a crucial role in the pricing of magazines.

2 The Model

The two-sided market model for the magazine industry is defined as follows: Each magazine produces content pages and ad pages for its readers and provides an advertising outlet for the advertisers. They maximize their profits by setting a cover price for the readers and an advertising rate for the advertisers. Readers buy the magazine and the advertisers advertise in the magazine if their net benefits are high enough. As it is a two-sided industry, the benefits of readers depend on the number of ad pages in the magazine and the benefits of advertisers depend on the number of readers of the magazine, as well as some other magazine characteristics.

Agents on both sides, namely readers (r) and advertisers (a), are heterogenous in their net benefit of joining the platform and these benefits are drawn from a continuous distribution. Hence, the agent i on side j , $j \in \{r, a\}$, decides to join the platform if his net benefits b_i^j are higher than a threshold level, \underline{b}^j . This threshold benefit level \underline{b}^j , depends on the relative price of the magazine for side j , P^j , the number of the agents (market share of the magazine) on the other side of the platform, $N^{j'}$ and unobservable magazine characteristics U^j . It should be noted that Sokullu (2015) uses data from local American newspapers which are monopolists in their distribution area. German magazine industry is composed of several segments and in each segment there are more than one magazine. Thus, we use the relative prices to capture the effect of prices of competitors in the same segment on the demand and network effect functions.¹ P^r denotes the relative cover price and P^a denotes the relative

¹I would like to thank to the anonymous referee for pointing out this issue.

ad rate.² Assuming that all agents whose net benefits are higher than the threshold level join the platform, the probability of joining the platform and hence the market share of the magazine on side j is given by:

$$N^j = P(b_i^j \geq \underline{b}^j(N^{j'}, P^j, U^j)) = 1 - F^j(\underline{b}^j(N^{j'}, P^j, U^j)) \quad (1)$$

where F^j is the cdf of the net benefits of agents on side j . Let $S^j(.) = 1 - F^j(.)$ be the survival function. Following Sokullu (2015) assume that the threshold benefit function is partially linear:

$$\underline{b}^j = \phi^j(N^{j'}) + P^j + U^j$$

then the demand system of readers and advertisers is given by:

$$N^r = S^r(\phi^r(N^a) + P^r + U^r) \quad (2)$$

$$N^a = S^a(\phi^a(N^r) + P^a + U^a) \quad (3)$$

Weyl (2010) shows that network effects play an important role in a two-sided market for the pricing strategy of the platform and may lead to optimal prices below marginal costs. Hence, it is important to specify them correctly in order not to have erroneous conclusions in any policy analysis. To prevent misspecification, we estimate the network effect functions on both sides, ϕ^r and ϕ^a nonparametrically.

3 Data

We use a data set on the magazine industry from Germany which is available online at www.medialine.de. It contains annual data on cover prices, ad prices, number of ad pages, number of content pages, and circulation numbers of German magazines for the year 2009.³

The unit of observation in the sample is a magazine and we have information on 171 magazines.⁴ In the original data set the magazines are grouped according to their content such as *actuality*, *DIY*, *women's*, *parents*, *tv*, etc. The sample consists of magazines from 17 different segments. The most frequent segment is the *weekly women's magazines* consisting

²I have also estimated a model where the relative number of agents are used as well as the relative prices, the network effect on the readers' side is still found to be nonlinear and non-monotone.

³The initial data set is quarterly, but we annualize it as the cover prices do not change within a year and ad rate data is supplied annually by the website.

⁴Given the fact that we estimate the model nonparametrically, the sample size might seem small. Sokullu (2015) shows, with a simulation analysis, that the NPIV estimator she uses works well even with a sample of 100 observations.

of 18% of the observations while the least frequent ones are *DIY* and *animals* each comprising 1.7% of the observations. The magazines in the sample are published by 25 different publishers. Some of the publishers own magazines only in one segment while some others are publishing for several different segments. The three most dominant publishers in the industry are publishing around 50% of the magazines in our data set.

As it is mentioned in the model the threshold benefit level depends on the relative price of the magazine in its segment. We construct the relative price of magazine m in segment G , as the price of magazine m divided by the average price of magazines in segment G .

$$P_m^r = \tilde{P}_m^r / \left(\sum_{i \in G} \tilde{P}_i^r / N_G \right)$$

where \tilde{P}_i^r is the individual (i.e. not relative) price of magazine i and N_G is the number of magazines in segment G . Relative ad rate is constructed in the same way.⁵ Note that by using relative prices we control for any change in the demand or network effect function that might be attributable to the price change of competitors.⁶

It is assumed that the advertisements are all the same size: one page. We do not have the data on the total number of firms which use the magazines as an advertising medium. Hence, for the advertisers' side, the market size is defined as the total number of all pages in a given magazine segment. For example, for women's weekly magazines the market size is the sum of the number of pages of all women's weekly magazines. Then the market share of the magazine on advertisers' side, N^a is given by the ratio of the number of ad pages to the total number pages of all magazines in a given segment. In reality, a magazine with a high share of advertisers has generally a high share of ad pages over total pages. We check the correlation between our constructed market share and the ratio of ad pages over total pages and find that they are highly correlated with a correlation coefficient equal to 0.6. The share of readers is constructed by dividing the circulation of a given magazine by the population over the age of 14. Summary statistics of our main variables are presented in Table 1.

4 Empirical Analysis

The demand system given in equations (2) and (3) is estimated nonparametrically. It should be noted that the main object of this paper is to estimate network effects on each side

⁵A similar construction of relative price is used in Griffith et al. (2015).

⁶Under this specification: $\frac{\partial N_m^r}{\partial P_k^r} = \frac{\partial S_m^r}{\partial P_m^r} \frac{\partial \tilde{P}_m^r}{\partial P_k^r} \neq 0$

Table 1: Summary statistics of the main variables

Variable	Mean	Std Dev.	Min	Max
Circulation	1,273,800	1,467,978	66,039	9,601,297
No. of Ad pages	543	496	5	2,664
No. of Content pages	2,200	1,406	79	6,236
Cover price	2.61	1.57	0.45	7.95
Adrate	16,701	11,765	1,450	67,004
Ad pages/Total pages	0.20	0.09	0.04	0.52

nonparametrically. We first invert the survival functions and obtain the following system:

$$H^r(N^r) = \phi^r(N^a) + P^r + U^r \quad (4)$$

$$H^a(N^a) = \phi^a(N^r) + P^a + U^a \quad (5)$$

where $H^j(.) = (S^j)^{-1}(.)$.

As all explanatory variables in equations (4) and (5) are endogenous, we use instruments. Following Kaiser and Wright (2006), the cover price is instrumented with the average cover price of the publisher's other magazines. It is assumed that the common underlying costs will affect the cover price of all other magazines of the same publisher while they are going to be uncorrelated with the unobservables in a particular magazine's demand equation. The ad rate is instrumented with the number of titles of the publisher. It is assumed that the number of titles of the publisher will be correlated with the ad rate through its effect on cost factors via economies of scale. Moreover, again following Kaiser and Wright (2006), the share of readers in the advertising demand equation is instrumented with the average circulation rate of the publisher's other magazines and the share of advertisers in the reader demand equation is instrumented with the average number of advertising pages of the publisher's other magazines. We checked the correlation of instruments with the endogenous variables. The correlation coefficients between relative price and average cover price of publisher's other magazines and between ad rate and the number of titles of the publisher are both equal to 0.17. Moreover the correlation coefficients between the share of readers and the share of advertisers and their corresponding instruments are 0.18 and 0.22, respectively.

Equations (4) and (5) are estimated by nonparametric instrumental regression for transformation models developed in Florens and Sokullu (2014) and used in Sokullu (2015). The results are given in Figures (1) and (2).⁷ First of all, as can be seen from the left panels of Figures (1) and (2), advertisers' demand for the magazine is less elastic than the readers' demand. Second, right panels of Figures (1) and (2) show that the estimated network ex-

⁷Results with confidence bands are available from the author upon request.

ternality functions for the two sides have different patterns. While the network externality function of advertisers on readers, ϕ^r , is nonlinear and nonmonotone, the network externality function of readers on advertisers, ϕ^a seems quite linear. The network effect of advertisers, ϕ^r is linear and decreasing up to 5% of ad share. Up to 2% ad share it takes positive values, and after that point, it takes negative values. Note that, in the model in *Section 2*, the market shares of the agents on both sides are given by the survival function of their net benefits. Given that the survival function is decreasing in its arguments, it means that, up to an advertiser share of 2%, increasing the advertiser share in magazines, increases the threshold benefit level and thus decreases the demand. One can say that readers do not benefit from magazines with too few advertisements. They start to get benefit only after 2% market share of the advertisers. This benefit keeps increasing up to 5%, it then starts decreasing. Hence readers' benefit is not continuously increasing as the amount of advertisements increases. Previous literature supports these results. Kaiser and Song (2009) conclude that readers of entertainment magazines like advertisements, however here we also show that they dislike too few advertisements. Although this may sound strange, considering the fact that readers appreciate informative ads, this result means that they are not satisfied with too little information. An example can be given from the *Monthly high-price women's* magazines. Readers of these magazines would not be satisfied to see the advertisement of just one product of one fashion brand, but they would like to see the ads of other brands and of other products.

Figure (2) shows the estimated network externality function on the advertisers' side. It can again be seen that the network externality function ϕ^a changes its sign over the interval. It takes positive values and decreases the survival, hence the demand function, up to a readership share of around 18%. However, the benefits of advertisers are increasing with the share of readers after this level. Thus, it can be concluded that advertisers do not benefit from advertising in a magazine with a very low level of readership. Another point worth noting is that, contrary to ϕ^r , this network effect function follows a linear pattern. The benefit of advertisers keeps increasing with the readership of the magazine once it passes the threshold level.

Note that in this paper, we aim to recover network effects in German magazine industry with the use of NPIV. Once we estimate the model with nonparametric methods, the results can be used as a guidance for parametric specification and estimation which might make further empirical analysis easier.

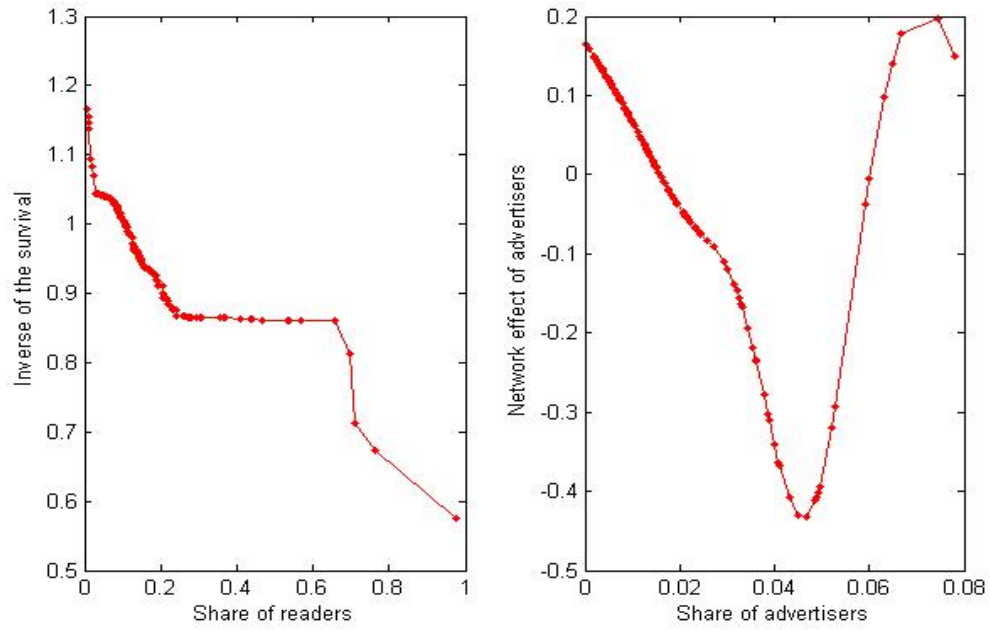


Figure 1: *Estimation results for readers' side*

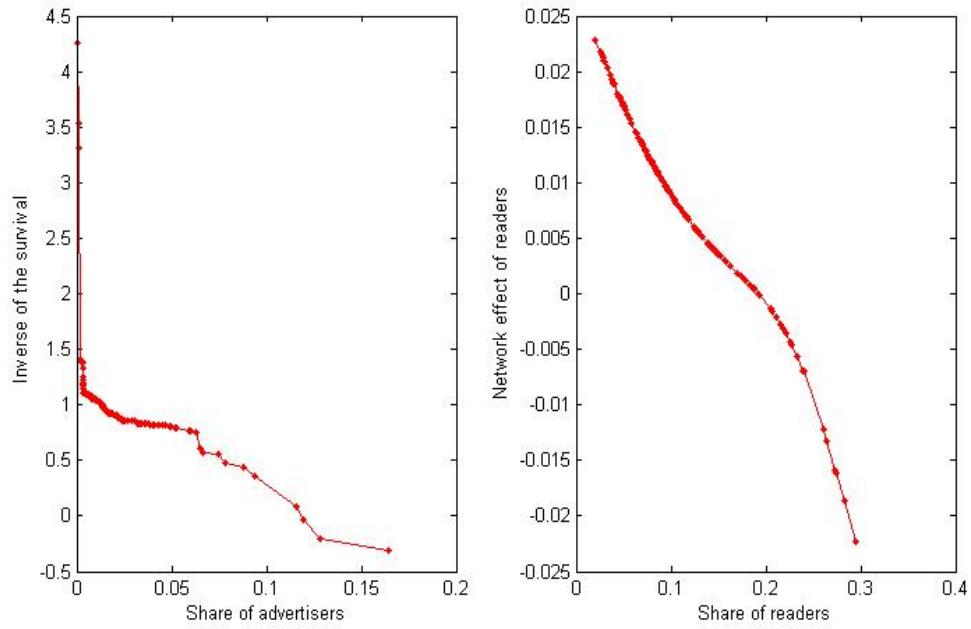


Figure 2: *Estimation results for advertisers' side*

5 Conclusion

Network effects play a crucial role in the pricing of the magazine. Hence, in any simulation exercise done for policy analysis, incorrect specification of these effects may lead to erroneous conclusions. Following Sokullu (2015), this paper nonparametrically estimates the two-sided network effect functions for German magazines. Three main results are obtained. First of all, we obtain well behaved downward sloping demand functions meaning that the model we set up in *Section 2* is supported by the data. Secondly, we show that neither readers nor advertisers benefit from too few agents on the other side of the platform. Finally, the network externality function on the readers' side is estimated to be nonlinear and nonmonotone while the network externality function on the advertisers' side follows a linear pattern.

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